

A SEASONAL DISTRIBUTION STUDY OF MUSCOID
FLIES OF KANSAS

by

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INTRODUCTION AND REVIEW OF LITERATURE

Reports reaching the Department of Entomology at Kansas State College during the 1957 fly season indicated that screw-worm flies and related species, are or may be a real threat to the continued economy of the livestock industry in Kansas. Reports of maggots infesting flesh wounds in livestock were coming to the Department of Entomology in the 1957 fly season as early as the latter part of April. These reports termed these maggots as "screw worms".

The screw-worm, Callitroga hominivorax, is a serious parasite of livestock. Haeussler (1952) reported that the annual loss suffered by livestock growers in the United States resulting from screw-worms during the years 1940-1944 averaged \$15,000,000.

Callitroga hominivorax is an obligatory parasite of warm-blooded animals. The fly deposits from 50 to 300 eggs in a mass on the edge of skin abrasions. Hatching usually occurs within 24 hours and the larvae crawl into the wound where they feed upon and destroy the living tissue. Infested wounds attract other screw-worm flies to oviposit, with the result that the host is often killed by the feeding maggots unless the wound is treated and the parasites destroyed.

Ever since the livestock industry was established in the United States, screw-worms have attacked cattle in the states adjoining our Mexican border (Bushland, 1953). In the summer,

screw-worm flies migrate northward from Texas at an average of about 35 miles per week to infest cattle in extreme northern areas. Natural migrations did not extend far east of the Mississippi River, and the parasite was unknown in the southeastern states. In 1933; however, screw-worm cases occurred in Georgia and Florida (Bruce et al., 1946), probably having reached there through shipment of infested cattle from Texas.

Clinical studies were made on guinea pigs experimentally infected with heavy, light, and lethal numbers of screw-worms. Attention was given to general condition and behavior, weight, temperature, erythrocyte and leucocyte counts of the hosts (Esslinger, 1955). About the third day after infestation, heavily infested guinea pigs began to show a sharp drop in weight, a marked rise in temperature and a leucopenis, all reaching an extreme between the fourth and sixth days. About the fifth day a drop in the erythrocyte count began and on the eighth day a definite anemia had developed. These manifestations coincided with the period of maximum growth of the third instar larvae. By the time the maggots had left the host (eighth day) animals had begun to gain weight and temperature and leucocyte counts were back to normal. The erythrocyte counts started returning back to normal range also after the eighth day. Since symptoms reached their peak before tissue destruction and decomposition was at its height, a toxic action by the growing parasites was suggested.

Callitroga hominivorax is a native of the warmer parts of

North and South America (Bushland, 1953). The insect is actually tropical and subtropical in its permanent distribution and it cannot survive the winter in areas where temperatures average below 50°F. for a consecutive period of 80 days (Bushland, 1953).

A survey made in 1950 around the Manhattan, Kansas area (Burkhardt and Dahm, 1953) showed the most frequently encountered flies were the house flies, Musca domestica L., green bottle flies of the genus Phaenicia, the black blow fly, Phormia regina, and flesh flies of the genus Sarcophaga. Other flies encountered only occasionally were species of Callitroga, including the primary screw-worm fly, Callitroga hominivorax, the stable fly, Stomoxys calcitrans (L) and flies of the genus Muscina.

The fly grill method of sampling the fly populations (Scudder, 1947) was used throughout the season.

Fly population surveys similar to those conducted at Manhattan were conducted by the U. S. Public Health Service at Lawrence, Kansas as a routine part of the Federal cooperative fly control program with the State Health Department at Topeka. Lawrence is located about 90 miles east of Manhattan in the Kansas River Valley. At Lawrence, as at Manhattan, the flies observed most commonly were Musca domestica, followed by Phaenicia, Phormia regina and Sarcophaga spp.

Blow flies, Phormia, and flesh flies, Sarcophaga, comprised less than ten per cent of the total fly population in either city. The highest numbers occurred early in the season (June) for the blow flies and flesh flies.

A further study (Schoof, 1955) reported from the Lawrence area for 1949 and 1950 fly seasons indicated that the most commonly observed flies for those seasons were also the house flies, followed closely by the green bottle flies, Phaenicia spp.

MATERIALS AND METHODS

Letters were sent to all County Agricultural Agents throughout the State asking for their help and cooperation in surveying the screw-worm population. Similar letters were sent to veterinarians, especially those who are sale barn inspectors, throughout Kansas. Individuals answering these requests were sent mailing tubes, two vials of Peterson's Fluid, (a preserving solution, made of ten parts 95 per cent isopropyl alcohol, two parts acetic acid, and one part diobase, measured by volume), and instructions to collect maggots from fresh wounds and return as soon as possible. When these samples were received they were removed from the Peterson's Fluid, washed in 70 per cent alcohol, and placed back into the same vials in 70 per cent ethyl alcohol.

Pasted around each vial sent to the cooperator was a small piece of paper asking for the following pertinent information: name, date collected, address, number of cattle infected, and approximate number of maggots per wound.

Five modified U. S. D. A. traps (Schoof, 1952) were borrowed from the State Health Department at Topeka, Kansas and three attached bait pan fly traps (Schoof, 1952) were

built by Building and Repair at Kansas State College. The traps were made at a total cost of \$53.26 to the Department of Entomology. The traps were baited with chicken entrails secured from a local poultry slaughtering establishment. Flies were collected daily during the first part of the season, and species and numbers of each recorded but it soon became evident that the total number of traps available would require too much time. As a result, all except the three attached bait pan traps were discontinued.

The attached bait pan trap consists of three main parts; the cage, bait pan, and metal standard. The cage (6.125 inches diameter x 8.125 inches high), has a built-in cone and a removable screened lid which is constructed to fit snugly over the upper rim of the bait pan. The bait pan can be described as a metal cylinder provided at the middle with a one and half inch rib of hardware cloth. One end of the cylinder is solid, except a few holes which allow for drainage of rain water which might accumulate. Both the cage and bait pan have a single stove bolt attached to one of the three verticle support strips.

The metal standard is constructed of 1.25 x 1.25 inch angle iron, 23.25 inches in length, fitted with a curved handle of strap iron. Two 5.25 inch sections of angle iron are welded to the standard, one at the top and the second at mid point. This second angle iron serves as a foot rest for forcing the standard into the ground, while the top bar serves as a hand

support. Two keyhole slots bored into the standard at appropriate locations receive the heads of the stove bolts fastened to the bait pan and cage.

For trap operations, a half pint ice cream carton containing the chicken entrails was placed into the open bottom of the cage and the two sections replaced on the standard as a unit.

Functionally the trap operates the same as the conventional types. Flies are attracted to the bait then move upwards towards the light source and through the cone into the cage.

Schoof (1952) reported that these traps are equally as efficient and as good for fly population studies as are the U. S. D. A. modified types which are larger and more costly to build.

A portable fumigation chamber, consisting of an air tight three gallon can with absorbent cotton saturated with carbon tetrachloride was used for killing the flies. As the flies were collected, the entire top part of the trap was removed from the standard, placed into the chamber, and allowed to remain there until the flies were knocked down. The flies were removed from the cage and placed into one-half pint ice cream cartons. Each day's trappings from separate traps was kept in a separate container.

The containers were numbered corresponding to the trap number and dated, then brought into the laboratory where they were placed in a freezer to kill any flies that might have recovered from the effects of the chemical. The flies remained

in the freezer until numbers and species could be recorded. Temperatures also were recorded for the area.

Traps were placed at three locations around the Manhattan area. They were placed in similar ecological habitats in order to get a more nearly representative picture for those ecological conditions relative to fly populations. Trap No. 1 was located near a vacant beef barn. The barn had been used in the previous winter but this summer was not in use except for a short while about mid July. Trap No. 2 was located at one of the swine barns which was used continuously throughout the season. Also located near-by was a pile of rotting straw which could serve as a breeding source for certain muscoid flies. Trap No. 3 was located near a dairy barn. It consisted of a milking parlor and cows were driven past the trap's location twice daily. During the early part of the season a large pile of refuse consisting of cow manure, old bedding, and rejected feed was located only a short distance from the trap but it was removed shortly after the trapping started.

Traps were rebaited at various intervals depending upon the weather and the stage of development of larvae feeding within the bait. When the larvae reached the third stage of development or just before they were ready to pupate, that bait was discarded and replaced with fresh.

RESULTS AND DISCUSSION

Survey of Maggots Infesting Wounds in Kansas

On April 28, 1958 the first sample of maggots was received from Kingman County, located in south central Kansas. These maggots were taken from a native sheep. According to the County Agricultural Agent no livestock had been shipped into that area from any areas to the south; therefore, it is unlikely that these maggots could have resulted from imported, infested cattle or other livestock. This was the only case of secondary screw-worms, Callitroga macellaria, received during the entire collecting period and fly season of 1958. The identifications of the larvae were verified by Mr. C. W. Sabrosky.

Two samples of maggots, collected April 29, one from Clay County in northeastern Kansas and one from Stafford County in central Kansas, were identified as Phormia regina (Meigen).

On April 30 a sample of Phaenicia spp. was collected in Harper County, in south central Kansas.

On April 22 two samples of P. regina (Meigen) were collected in Garden City, in southwest Kansas; and one at Seneca, in the extreme northeastern part of Kansas, collected May 8.

The only samples of maggots exclusively Sarcophaga spp. were received from the County Agent at Meade County in southwestern Kansas, having been collected May 20. One vial

received July 8 contained a few Sarcophaga spp. mixed with maggots of other species.

The following samples of P. regina (Meigen) were collected: in Ford County, July 14; Ellis County, July 18; and Lincoln County, August 8. These counties are in central Kansas.

Succeeding samples of maggots received during the remainder of the season were identified as either P. regina, Sarcophaga spp. or Phaenicia spp. with three exceptions: one Oestrus ovis; one Cuterebra spp. and four vials of the primary screw-worm, Callitroga hominivorax.

Cuterebra sp. was sent in by a veterinarian from Wichita. It had been removed from under the fore leg of a domestic cat, on August 5.

On August 24 samples of the sheep nose bot, Oestrus ovis, were collected by a farmer in Marion County, in south central Kansas.

On August 29, 1958, a veterinarian in Clarke County in southwestern Kansas bordering Oklahoma, collected and sent to the writer specimens of the primary screw-worm. That was the earliest date that any primary screw-worms were collected for the writer during the 1958 fly season. All subsequent samples of maggots received were the primary screw-worms.

Maggots collected at Peabody on September 18, from the infested navel of a three day old calf, were also identified as C. hominivorax. An accompanying letter by the collector stated that there had been very little trouble with screw-worms this

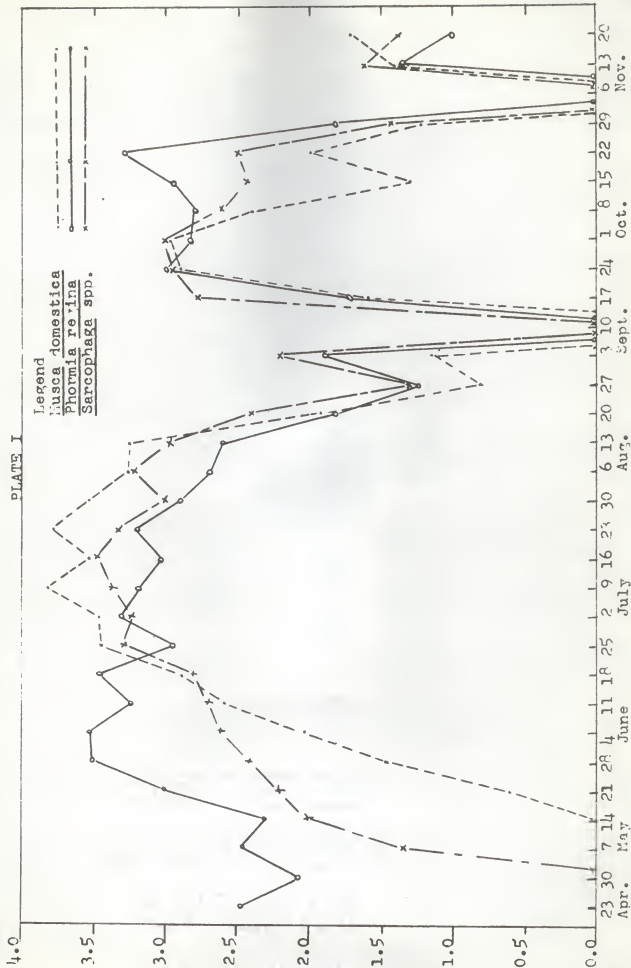
year as compared to many previous years and that he was not in a position to know whether any other livestock had been shipped into that area from the south. Peabody is in Marion County in south central Kansas. This was the furthest north record of C. hominivorax during the 1958 fly season.

This survey did not prove entirely successful or did it become as extensive as the writer had planned. The County Agricultural Agent, Assistant Agent, Associate Agent, or a veterinarian in 57 counties had stated that they would help in the survey. Actually, however, all of the specimens received from the counties over the State were received from 17 of the 107 counties in Kansas. The counties reporting attacks by saprozoic maggots were scattered roughly from the northeastern part of Kansas diagonally to the southwestern corner.

This survey was probably not complete because in a survey made by David L. Matthew, Kansas Economic Survey Entomologist in 1954 by questionnaires sent out to 55 County Agricultural Agents, a total of 54 responded to the questionnaire and returned it. Of the 54 agents answering, 47 stated they had had outbreaks of screw-worms that season. Seven stated they had no questions or trouble with screw-worms that year. The counties which reported problems were located over the entire State, no one county reporting any heavier loss than another. Neither was there any indication that any definite trend in infestations was more serious in one part of the state than in another, except that C. hominivorax was found in some cases and others

EXPLANATION OF PLATE I

Logarithmic graph of *Musca domestica*, *Sarcophaga* sp. and *Phormia regina* against weekly total collections from three traps.



of less importance in other counties. Matthew had no way of knowing if the infestations were primary screw-worms or other types of saprozoic maggots and it is the opinion of the writer and Matthew that many of the infestations were not primary screw-worms but some other species, probably Phormia regina of C. macellaria, these assumptions based on results of the 1958 survey.

Adult Muscoid Flies

Trappings in the Manhattan area as previously described were started on the 16th of April and continued until November 20. Previous to this date there had been several killing frosts. Trap No. 3 in the vicinity of the dairy barn produced the most flies during the first few days, yielding some 90 Calliphora vicina, per day. Counts remained comparable for several days, then dropped to low numbers similar to the other traps.

Musca domestica. Schoof (1955) reported that qualitative appraisals show the percentage of blow flies is greater in trap surveys whereas grill surveys yield proportionately higher indexes of house flies. The increased incidence of blow flies in traps apparently stems to a large degree from the greater attraction of Phaenicia and Phormia to the chicken entrail baits. The data show that Musca domestica was the species most commonly attracted to the baits, Plate I.

Schoof (1955) reported the first M. domestica trapped in 1949 at Lawrence were taken during the first week of May and

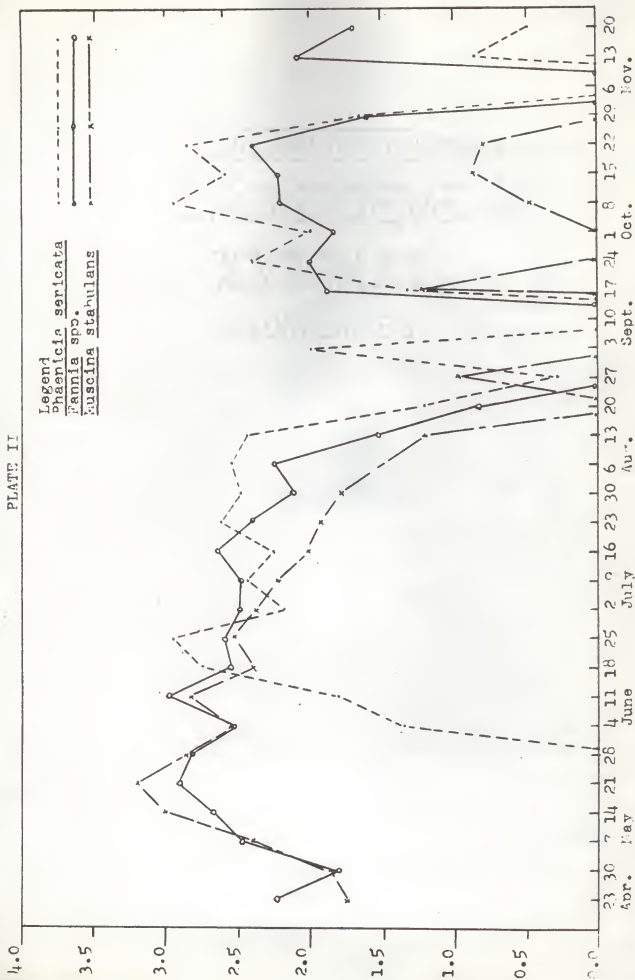
the peak reached during the third week of July. In 1950, the first M. domestica were taken the second week of May with the peak the last week of July. These data agree very closely with the 1958 data (Plate I) when the first specimens were captured during the first week of May, one peak occurring during the second week of July, dropping off rapidly during the third week, and then returning to nearly the same level the following week as previously recorded. Numbers declined to very low levels during late August and early September. After this date the counts rose until the first week in November when the counts again dropped to zero. Then counts came back up and a total of 47 specimens were taken during the second week in November. The total numbers of these flies represented 28.12 per cent of the total flies captured.

Phormia regina. At Lawrence in 1949 and 1950, P. regina ranked second in abundance and represented 23.5 per cent and 23.1 per cent of the total flies collected, respectively (Schoof, 1955). The writer's data show similar trends in 1958, since this species ranked second in abundance (Plate I) and represented 24.73 per cent of total flies, but differed from Schoof's data in that the peak at Manhattan occurred in early June. Schoof reported peaks at about the third week of June with a slight rise in numbers at about the second week of August. The data at hand indicate another corresponding slight rise occurred in the third week of October which was not as high as the first peak of June.

EXPLANATION OF PLATE II

Logarithmic graph of Fannia spp., Calliphora vicina, and Phaenicia sericata against weekly total collections from three traps.

PLATE II



Sarcophaga spp. The combined species of this genus were the third most abundantly trapped muscoid flies, representing 18.43 per cent of the total. No attempt was made to identify these any further than genus. This genus was not in Schoof's report; however, these flies are important in that they are saprophagous insects. No Sarcophaga were trapped until the first week in May. After the first specimens were captured, counts for succeeding weeks became progressively higher until the fourth week of June when the first peak came. In the succeeding two weeks the counts were somewhat lower and the count during the third week of July reached an all time high for the trapping period. After this high was reached the numbers dropped quite rapidly until the second week of September when none were trapped. After this date the numbers again peaked the last week of September. Small numbers of Sarcophaga spp. were still being taken when the project was discontinued.

Among the Sarcophaga trapped were: S. rapax; S. bullata; S. grassipalpis; and S. sarracenioides.

Fannia spp. As indicated by Plate II, Fannia spp. ranked fourth in abundance for the collecting period, representing 6.16 per cent of the total flies. Several were trapped the first week indicating that they began to emerge before the collecting started. These flies were not listed in literature surveyed. The lesser house fly resembles the house fly except they are about one-half their size. These flies reached a

peak in abundance the second week of June.

Phaenicia sericata. Ranking fifth and representing 5.26 per cent of the total numbers collected was P. sericata (Plate II). Specimens were not trapped until the first week of June. This species peaked during the third week in June; thereafter, the counts went down rapidly and continued in erratic sequence until the second week of September when no specimens were trapped. After this period, numbers again rose, this particular species going higher during the second week of October than it had at any previous period.

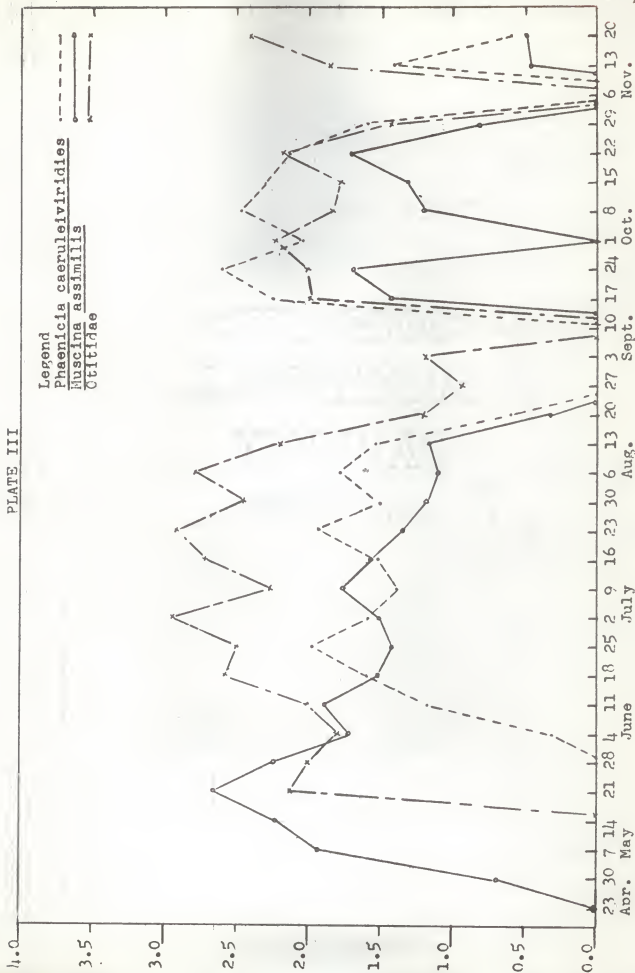
These data are similar to those of Schoof for 1949, in that there were two periods of maximum density. Schoof indicated that the two peaks in 1949 were closer together and that the first peak was larger than the second. His data showed that P. sericata was trapped during the second week of April with the first peak occurring the first week of June, the second occurring the third week of July and after that date, the counts dropped to negligible numbers. In 1950 these flies were trapped as early as May. During the third week of June the counts showed a slight peak; however, in that period of trapping the largest peak occurred during the second week of August. After that date the numbers dropped to zero during the last week of August. In September the counts again rose slightly.

Muscina stabulans. Ranking sixth in number was the false

EXPLANATION OF PLATE III

Logarithmic graph of Otitidae, Phaenicia caeruleiviridis,
and Muscina stabulans against weekly total collections
from three traps.

PLATE III



stable fly, M. stabulans, which accounted for 4.9 per cent of the total flies, (Plate II). This was one of the species that prevailed throughout the trapping period. The peak occurred in the third week of May.

This species, although closely related phylogenetically to M. domestica differed greatly in relative abundance. These flies were trapped in considerable numbers early in the season. The first M. stabulans were trapped on the first date of collecting and the peak was reached in the third week of May. After this peak, numbers dropped considerably until the third week of August when none were collected. Specimens captured after this date were negligible. There was, furthermore, no large second peak as with some of the other species.

Schoof reported that in 1949 and 1950 this species was the least prevalent in the Lawrence area.

Otitidae. This family ranked seventh in abundance and accounted for 4.70 per cent of the total flies. No attempt was made to identify these further than family; however, the species most numerous was Chrysomya domendata.

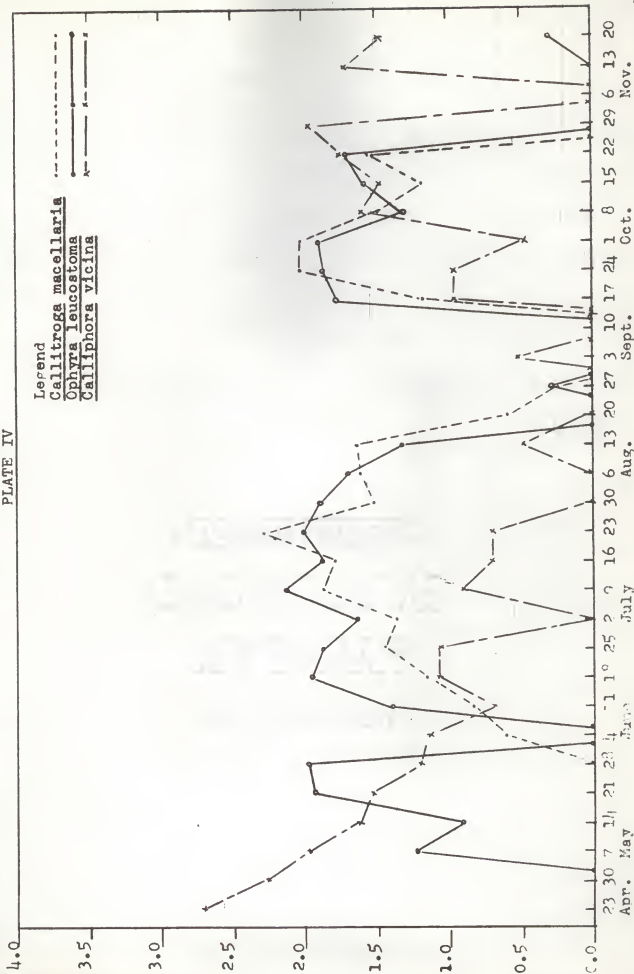
Schoof's report did not list this species and no other literature was found which gave relative abundance of this fly.

The Otitidae, (Plate III) in 1958 were first collected during the third week of May. These flies were erratic in numbers collected, but a peak occurred in the latter part of June and early July. In the second week of September no specimens were collected but they again showed up the following

EXPLANATION OF PLATE IV

Logarithmic graph of *Cynomyopsis cadaverina*, *Muscina assimilis*,
and *Callitroga macellaria* against weekly total collections
from three traps.

PLATE IV



week and were being collected in greater abundance than any other species when the project was discontinued.

Phaenicia caeruleiviridis. These were the eighth most abundant species of flies collected accounting for 1.64 per cent of the total numbers (Plate III). Like P. sericata, this species was not trapped until the first week of June, but it reached a peak much later than P. sericata; the peak was reached the last week of October, just two weeks earlier. Schoof reported that this species made up less than 1.1 per cent of the total flies trapped in 1949 or 1950 in the Lawrence area.

Phaenicia pallescens. In Schoof's report this species was relatively abundant in the Lawrence area in 1949 but in 1950 was of little or no consequence. The writer's study indicated that it was found in very low numbers late in the season and in so few numbers that it was combined with the "Others" group and considered of minor relative importance. Schoof reported that P. pallescens occurred as early as the last week of June but this writer found none until the first week of August.

Muscina assimilis. Ninth in abundance and only slightly less common than P. caeruleiviridis was M. assimilis, accounting for 1.21 per cent of the total flies captured. The relative abundance and peak numbers was closely correlated, both in numbers and date of appearance, with that of M. stabulans. The peak numbers of both were collected in the third week of May. Data show that this species was emerging for the remainder of the trapping period, (Plate III). Schoof reported the major

prevalence levels were reached during the summer months in 1949 and 1950.

Calliphora vicina. Shown in Plate IV, ranking tenth in relative abundance and accounting for 1.19 per cent of the total flies during the 1958 fly trapping period was C. vicina.

It was evident from the large numbers trapped on the first date of collecting that these flies were emerging before trapping was started. More of this species were collected during the first week of trapping than any of the succeeding weeks. During the summer months, including the last week of June and continuing till the second week of October, the numbers of this species were low and considered negligible.

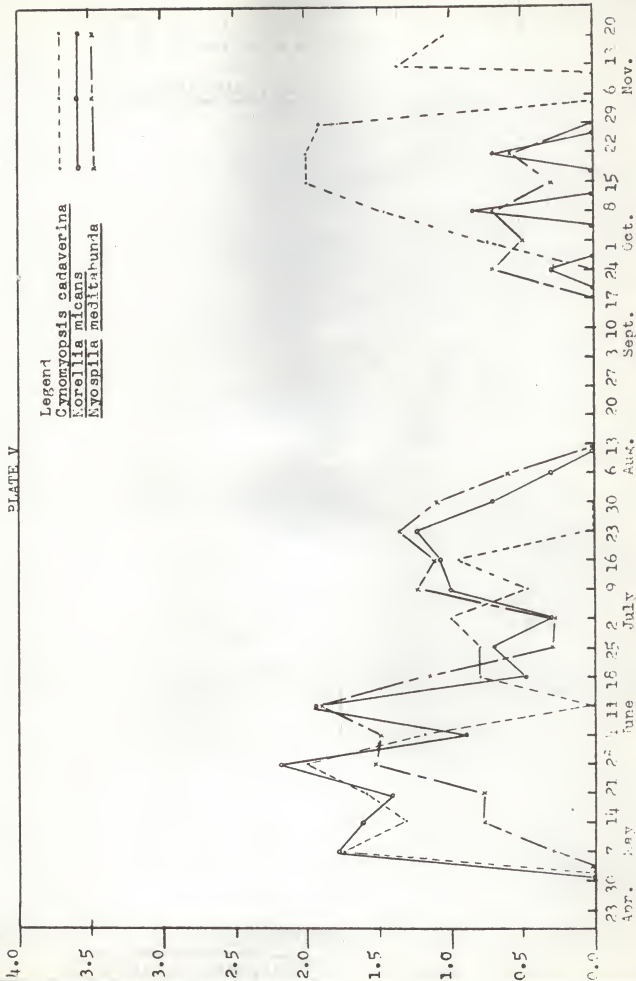
No previous report on relative abundance of this species occurs in the literature for the Manhattan or Lawrence area, but from this writer's data it was evident that these flies are most certainly cool weather preference species.

Cynomyopsis cadaverina. Following much the same trend as the previously discussed species except that they peaked twice in the trapping period were C. cadaverina (Plate V). The first peak was reached in the last week of May when the total number for the three traps reached 100 individuals. The numbers trapped in successive weeks following this high, were very low until the second week in October when the counts began to rise and peaked during the third week of October at a total of 101 specimens. After this high, the counts again became successively lower for the following weeks. These flies accounted for .51

EXPLANATION OF PLATE V

Logarithmic graph of Morellia micans, Obiura leucostoma, and Myosnila mediatubunda against weekly total collections from three traps.

PLATE V



per cent of the total flies captured.

Ophyra leucostoma. Shown in Plate IV, O. leucostoma ranked eleventh in relative abundance during the 1958 trapping period, accounting for 1.41 per cent of the total flies captured. Schoof reported that O. leucostoma ranked sixth in 1949 and fifth in 1950 at the Lawrence trapping station. This was only considering selected species which he considered important. In 1949 he showed that the maximum population was in June, decreasing in late July. In 1950 he reported a much higher incidence but the times of rise and fall in numbers were similar to the previous season.

The writer's data indicated a similar maximum curve except that it occurred in the second week of July in the 1958 season which is about three weeks later than the comparable data for 1949 and 1950. There was a later rise in relative abundance but it came in the last week of September and the first of October, much later than the previous years data indicated.

Callitroga macellaria. The secondary screw-worm, (Plate IV) ranked twelfth in relative abundance during the 1958 fly trapping period and represented .71 per cent of the total flies trapped. These data cannot be entirely correlated with those of Schoof because, as previously stated, his data dealt only with ten related species of major importance, while this survey deals with all species trapped during the 1958 trapping period. Schoof reported that the secondary screw-worm ranked fourth and fifth in abundance in 1949 and 1950, respectively. He stated

EXPLANATION OF PLATE VI

Logarithmic graph of Graphomya maculata and "Others"
against weekly total collections from three traps.

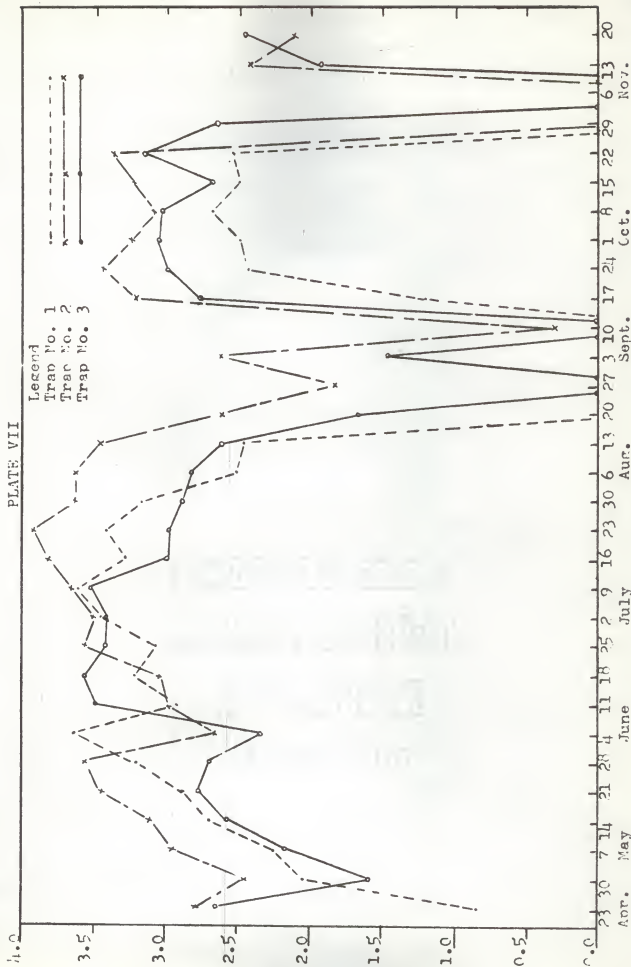
PLATE VI



EXPLANATION OF PLATE VII

Logarithmic graph indicating numbers of flies collected per trap, plotted against weekly collective totals.

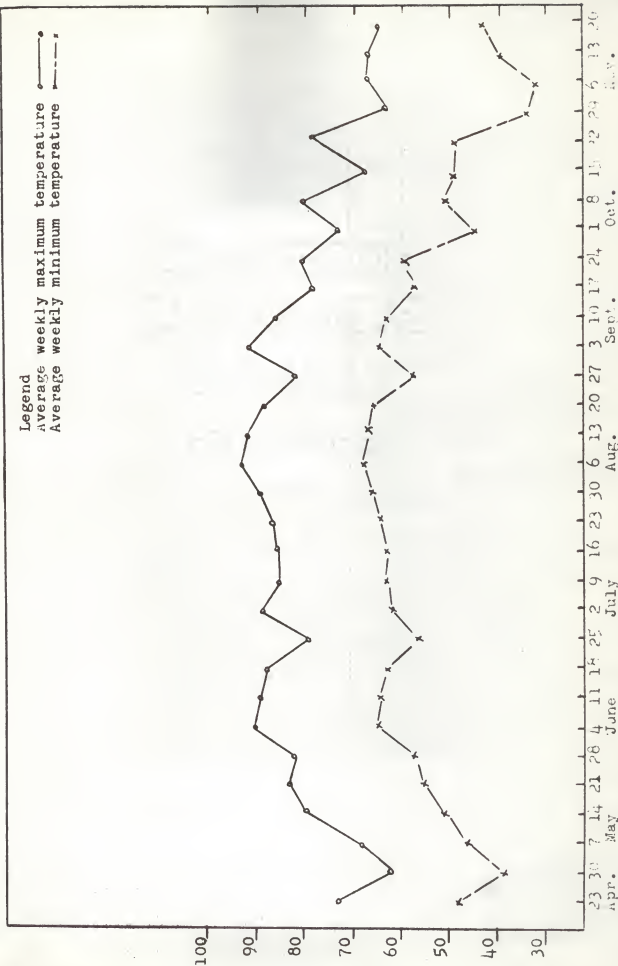
PLATE VII



EXPLANATION OF PLATE VIII

Graph showing average maximum and minimum weekly temperatures for the 1958 fly trapping period.

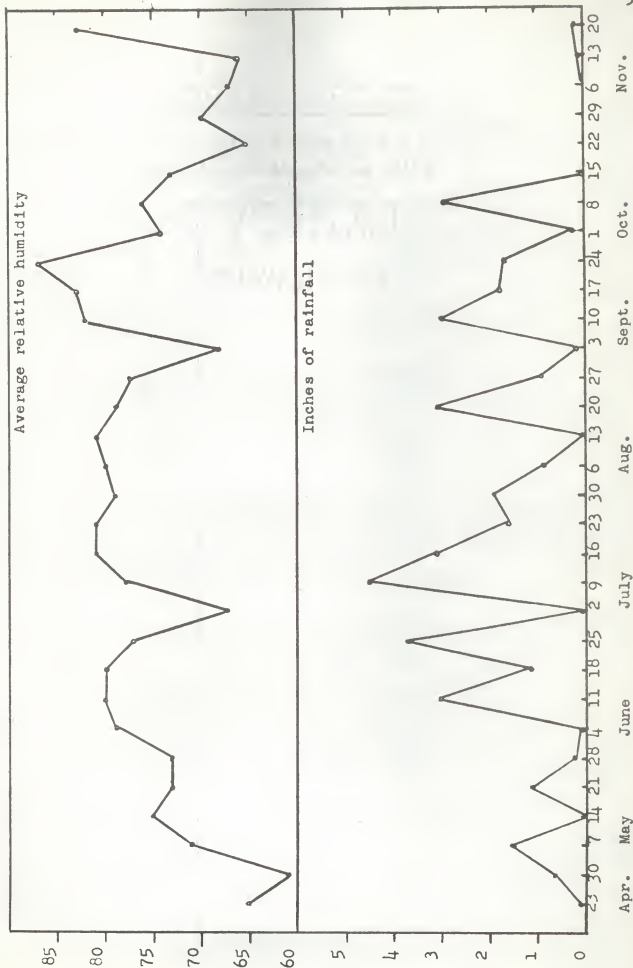
PLATE VIII



EXPLANATION OF PLATE IX

Graphs showing weekly average relative humidity for the 1958 fly trapping period, and showing total weekly rainfall for that period.

PLATE IX



further that this species was collected as early as April and continued until November, with the peak occurring during the summer months. These results differed from those during the 1958 fly season in that secondary screw-worm flies were collected during the last week of May with the maximum density occurring the third week of July and had disappeared by the third week of October.

Morellia micans, Myosvila mediatubunda and Graphomya maculata, shown in Plates V and VI are all closely related species. These species ranked fourteenth, fifteenth, and sixteenth, respectively in relative abundance. Their combined total numbers amounted to only .65 per cent of the total flies trapped. These species reached a peak in May and then dropped to very low levels. They were all trapped throughout the trapping period until during the third week of October after which none were captured. Graphomya maculata was the only species which was captured more abundantly at some trap other than trap No. 2. The trap yielding the highest numbers of this species was No. 1, located at the beef barn. None were reported in former reports but from the writer's data, one could surmise that they might be of importance early in the season and of less importance when the weather gets warmer.

Others. Among Other species (Plate VI) were: Lucilia illustris; Phaenicia pallescens; Tachinidae; Calliphora livida; Calliphora vomitoria; Cryptolucilia caesarion; Hydroteae houghii; Limnophora arcuata; Siphona irritans; Stomoxys calcitrans;

Syrphidae; Asilidae and others. These individuals accounted for only .75 per cent of the total numbers captured during the entire fly trapping period.

Weather

The periods of trapping which yielded the largest total numbers of flies were in the first, second and third weeks of July (Plate VII). Maximum temperatures for these weeks averaged 85°, 86°, and 86° F., respectively, while the average minimum temperatures were 63°, 63°, and 64° F., respectively, as shown by Plate VIII.

These weeks included the periods of heaviest rainfall for the entire trapping period. The first week of July was the week with the highest rainfall for the entire season, amounting to 4.65 inches. During the succeeding two weeks, counts were slightly lower than that first week. Rainfall for these succeeding weeks amounted to 3.05 and 1.58 inches, respectively, as shown by Plate IX.

Weeks offering very low population of flies occurred during the last week of August and the first two weeks of September. The average maximum temperatures for these weeks were 82°, 92°, and 86°F., respectively. Total precipitation for each of these weeks was as follows: .82, .12 and 3.87 inches.

Total rainfall for 1949 comparable trapping period was the same as for the 1958 period with the total rainfall for both periods amounting to 38.5 inches. For the comparable period in

1950 the total precipitation was 37 inches.

A reason for the lower counts of flies during this period of relatively equal temperature and rainfall might be due to grass and thistles having grown up around the traps making it difficult for the flies to enter them.

Late in the trapping period, starting on October 22 and continuing to the end of the trapping period, no flies were taken from Trap No. 1, as shown by Plate VII. The reason for this was that each day the traps were inspected it was found that the bait had been removed from this particular trap and frequently it was found overturned and the cage separated from the attached bait pan.

SUMMARY

A survey conducted during the 1958 fly season indicated that livestock in Kansas were infested with saprozooic parasites very early in the season, in most cases by the black blow fly; Phormia regina. The first spring case reported; however, was the secondary screw-worm, Callitroga macellaria.

There was no indication that the primary screw-worm C. hominivorax did overwinter in Kansas, although overwintering by C. macellaria was indicated since the livestock in which it was reported were native to that area and no animals had been shipped in.

No adult Callitroga hominivorax were captured in the traps during the entire fly season which was to be expected because

of the type of bait used. Larvae were collected on August 29 in Marion County, south central Kansas, and may have been the results of natural migrations to the north by the adults. Specimens collected were from the navel of a three day old calf.

Other species collected from livestock wounds included Phaenicia spp., Phormia regina, and Sarcophaga spp.

In trapping adult muscoid flies during the fly season in 1958 in the Manhattan area the early appearing flies in large numbers were: the black blow fly, Phormia regina; the blue bottle fly, Calliphora vicina; lesser house flies, Fannia spp.; and the false stable fly, Muscina stabulans.

Flies appearing later in the season and relatively abundant included the house fly, Musca domestica; green blow flies, Phaenicia sericata and P. caeruleiviridis; and the secondary screw-worm, Callitroga macellaria.

Flies appearing most numerous during the entire period of trapping were M. domestica accounting for 28.12 per cent of the total numbers captured, Phormia regina for a total of 24.73 per cent, and the Sarcophaga spp. accounting for 18.43 per cent. Species of Sarcophaga trapped included: S. rapax; S. bullata; S. crassipalpis; and S. sarracenioides.

Other adult flies trapped included: Muscina assimilis; Otitidae; Ophyra leucostoma; Cynomyopsis cadaverina; Myospila mediatubunda; Morellia micans; Graphomya maculata; Syrphidae; Lucilia illustris; Phaenicia pallens; Tachinidae; Calliphora livida; Calliphora vomitoria; Cryptelucilia caesarion; Hydroteae

houghii; Limnophora arcuata; Siphona irritans; Stomxys calcitrans;
and Asilidae.

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LITERATURE CITED

- Bruce, W. G.
Screw-worms. In U. S. D. A. Yearbook. 1952. 666-71 p.
- Bruce, W. G., A. L. Smith and C. C. Skipper.
Screw-worm survey in the southeastern states in 1945.
Florida Entomologist 29:1-4. 1946.
- Burkhardt, C. C. and Paul A. Dahm.
An urban fly control campaign. Journal of Economic Entomology 46; 3, 409-14. July, 1953.
- Bushland, Raymond C.
Sterilization of the screw-worm fly Callitroga americana (C. and P.), with X-rays or gamma-rays. Unpublished Ph.D. thesis, Kansas State College, Manhattan, Kansas. 1953.
- Dodge, Harold R.
A possible case of myiasis in a rat, with notes on the bionomics of Eufelucilia silvarum (Meigen).
- Dodge, Harold R.
Identifying common flies. Public Health Reports. 68, (3). March, 1953.
- Esslinger, Jack H.
Studies on the clinical effect of the screw-worm. Journal of Parasitology 41:33 December, 1955.
- Haeusesler, G. J.
Losses caused by insects. In U. S. D. A. Yearbook 1952. 141-46 p.
- Hagmann, L. E. and G. W. Barber.
Overwintering habits of Phaenicia sericata (Mg). Journal of Economic Entomology 41:510. 1948.
- Hall, David G.
The blowflies of North America. Baltimore:Thomas Say Foundation. 1948. 477 p.
- Hewitt, C. G.
Notes on the pupation of the house fly (Musca domestica) and its mode of overwintering. Can. Ent., 47:73-8. 1915.
- James, Maurice T.
The flies that cause myiasis in man. U. S. D. A. misc. Pub. 631. 1947(1948).

- Mail, G. A. and H. F. Schoof.
Overwintering habits of domestic flies at Charleston, West Virginia. Annals of the Entomological Society of America. 47:(4) December, 1954.
- Matthysse, J. G.
Observations on house fly overwintering. Journal of Economic Entomology 38:493-4. 1945.
- Quarterman, K. D., J. W. Kilpatrick, and Willis Mathis.
Fly dispersal in a rural area near Savannah, Georgia. Journal of Economic Entomology 47(3) 413-19. June, 1954.
- Roberts, R. A.
The wintering habits of muscoid flies in Iowa. Annals of Ent. Soc. America: 23; 784-92. 1930.
- Schoof, H. F.
The attached bait pan fly trap. Journal of Economic Entomology 45: 4, 735-6. November, 1952.
- Schoof, H. F.
Survey and appraisal methods for community fly control programs. Public Health Monograph. No. 33. January, 1955.
- Schoof, H. F. and G. A. Mail.
Dispersal habits of Phormia regina in Charleston, West Virginia. Journal of Economic Entomology 46: (2) 258-62. July, 1953.
- Schoof, H. F. and E. P. Savage.
Comparative studies of urban fly populations in Arizona, Kansas, Michigan, New York, and West Virginia. Annals of the Entomological Society of America. 48(1-2) 1-12. January-March, 1955.
- Schoof, H. F., E. P. Savage, and H. R. Dodge.
Comparative studies of urban fly populations in Arizona, Kansas, Michigan, New York, and West Virginia II. Seasonal abundance of minor species. Annals of the Ent. Soc. of Am. 49 (1) 59-66. January, 1956.
- Schoof, H. F. and R. E. Siverly.
Multiple release studies on the dispersion of Musca domestica at Phoenix, Arizona. Journal of Economic Entomology. 47, (5) 830-38. October, 1954.
- Schoof, H. F., R. E. Siverly, and J. A. Jansen.
House fly dispersion studies in metropolitan areas. Journal of Economic Entomology; 45 (4) 675-83, November, 1952.

Scudder, H. I.

A new technique for sampling the density of house fly population. U. S. Public Health Service. Public Health Reports 62:681-86. 1947.

Siverly, R. E. and H. F. Schoof.

Utilization of various production media by muscoid flies in a metropolitan area. I. Adaptibility of different flies for infestation of prevalent media. Annals of the Entomological Society of America 48, 4, 258-62. July, 1955.

A SEASONAL DISTRIBUTION STUDY OF MUSCOID
FLIES OF KANSAS

by

CHARLES STUART RATCLIFF

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Many reports had been received by the Department of Entomology early in the 1957 fly season from different parts of Kansas, indicating that livestock men were having trouble with screw-worms. As a result, a survey was undertaken to determine if a real problem existed early in the season with the primary screw-worm, Callitroga hominivorax, and County Agricultural Agents and veterinarians throughout the state were asked to cooperate in securing specimens of maggots from flesh wounds of livestock.

As a comparison study, three fly traps were operated in the Manhattan, Kansas area in similar ecological conditions to provide information on relative numbers and seasonal prevalence of flies attracted to baited traps. The traps were U. S. D. A. modified, attached, bait pan fly traps baited with chicken entrails.

There was no indication that the primary screw-worm C. hominivorax did overwinter in Kansas, although overwintering by C. macellaria was indicated since the livestock in which it was reported were native to that area and no animals had been shipped in.

No adult C. hominivorax were captured in the traps during the entire fly season which was to be expected because of the type of bait used. Larvae were collected on August 29 in Marion County, south central Kansas, and may have been the result of natural migrations to the north by the adults. Specimens collected were from the navel of a three day old calf.

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